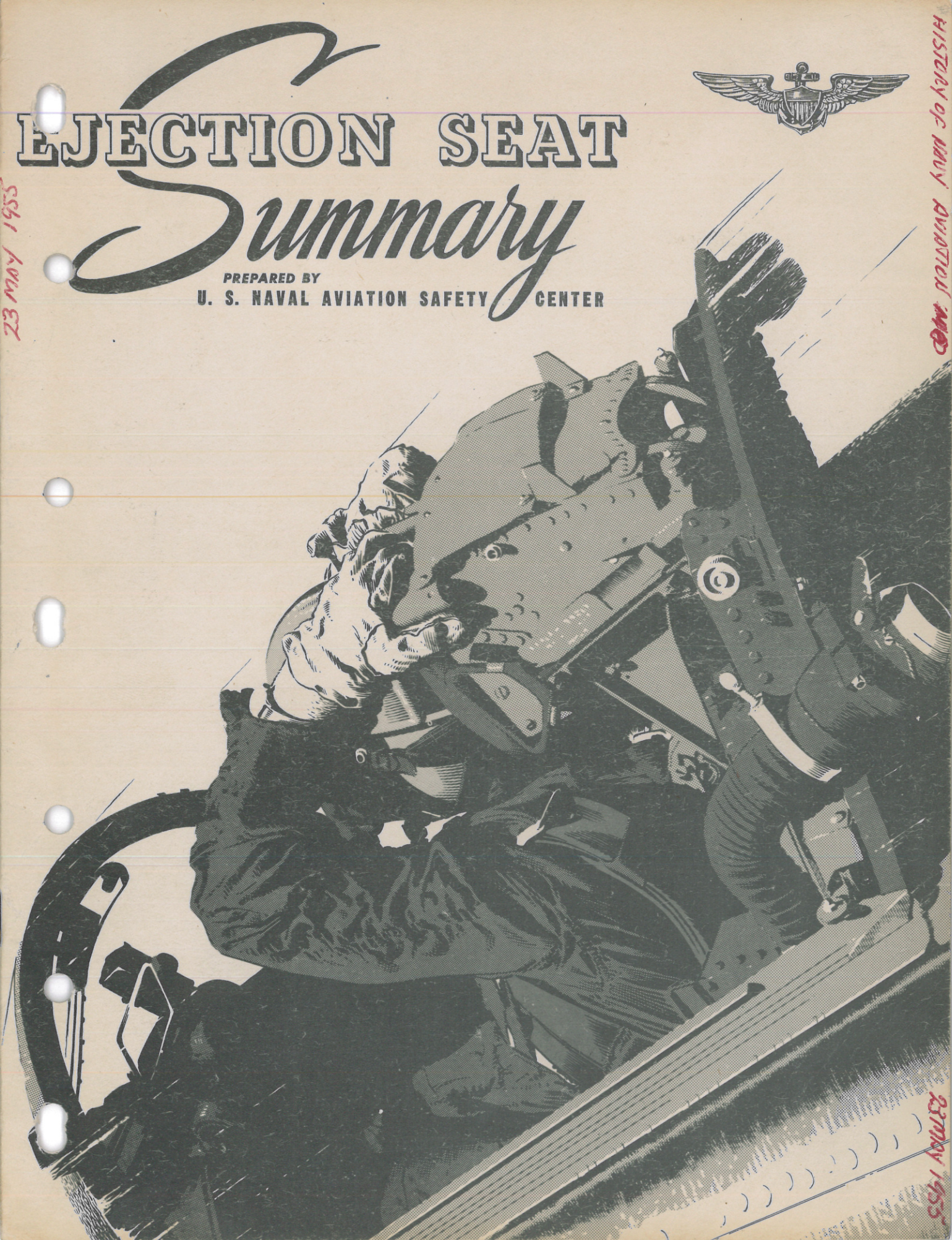
EJECTION SEAT Summary

PREPARED BY
U. S. NAVAL AVIATION SAFETY CENTER



EJECTION SEAT Summary

PREPARED BY
U. S. NAVAL AVIATION SAFETY CENTER

U. S. NAVAL AVIATION SAFETY CENTER
U. S. NAVAL AIR STATION
NORFOLK 11, VIRGINIA

23 May 1955

From: Director
To: Distribution List

Subj: Ejection Seat Summary; promulgation of

1. Presented herein is a report on the ejection seat in emergency escape from U. S. Navy aircraft from the first ejection in August 1949 through 30 June 1954.

2. Purpose. The purpose of this study is to:

a. Present an analysis of the emergency uses of the ejection seat for the period covered.

b. Appraise operating commands of the ejection seat record.

c. Present brief discussions concerning the factors which influence the success of the ejection procedure.

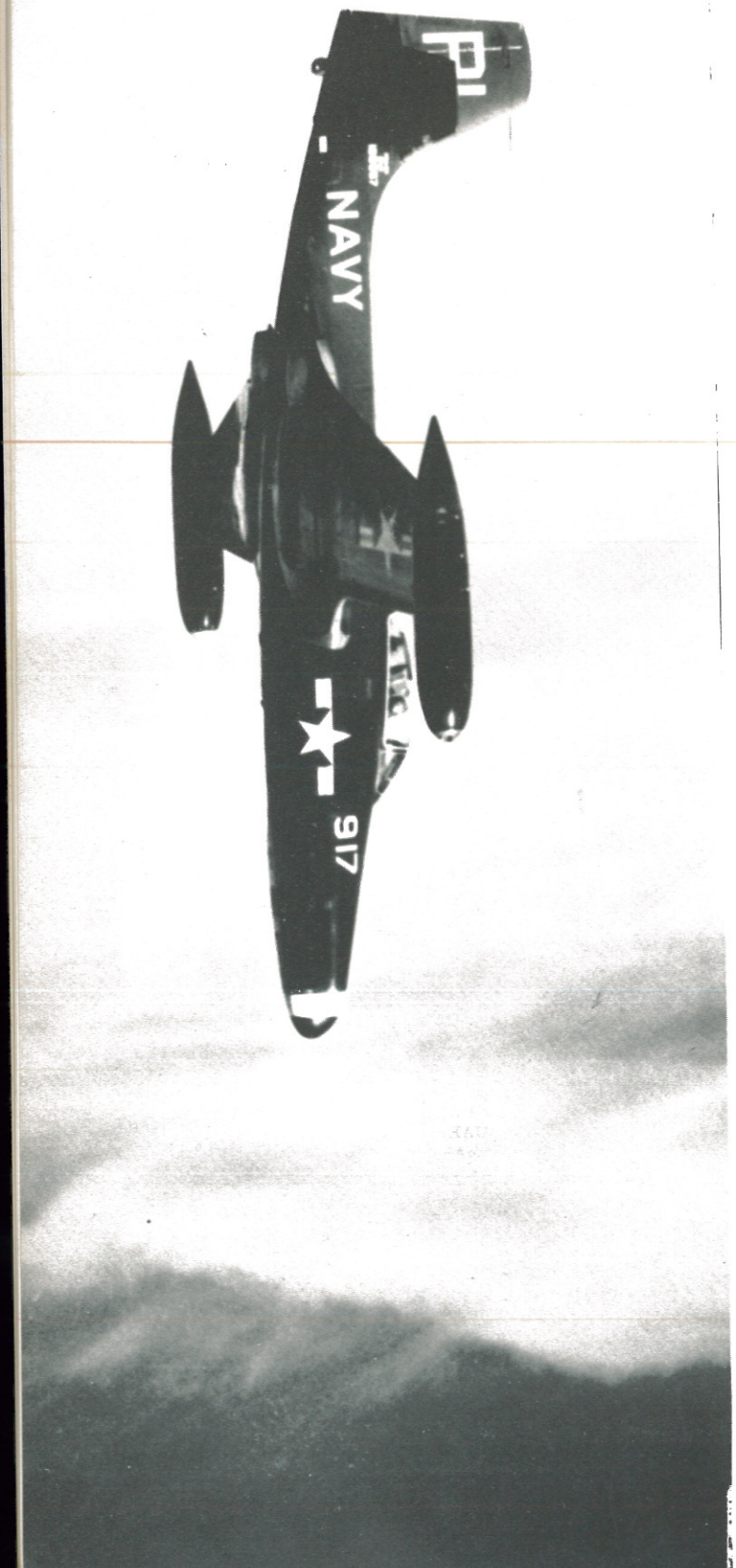
3. Continuity: This is the third report on emergency usage of the ejection seat prepared by the Naval Aviation Safety Center. It will be noted that the report considers all of the ejections which have occurred through 30 June 1954 and thus includes the information contained in the previous reports. It is anticipated that additional reports will be prepared as the usage of the ejection seat increases.

4. Distribution: Activities on the distribution list receive copies as indicated. A limited number of copies are available to other interested commands and may be obtained from the U. S. Naval Aviation Safety Center upon request.

J. W. BYNG

DISTRIBUTION

	copies
VF 11	2
VF 12	2
VF 13	2
VF 21	2
VF 22	2
VF 23	2
VF 24	2
VF 31	2
VF 32	2
VF 33	2
VF 34	2
VF 41	2
VF 43	2
VF 44	2
VF 51	2
VF 52	2
VF 53	2
VF 61	2
VF 62	2
VF 63	2
VF 64	2
VF 71	2
VF 72	2
VF 73	2
VF 74	2
VF 81	2
VF 82	2
VF 83	2
VF 84	2
VF 91	2
VF 92	2
VF 93	2
VF 94	2
VF 101	2
VF 102	2
VF 103	2
VF 111	2
VF 112	2
VF 113	2
VF 114	2
VF 121	2
VF 122	2
VF 123	2
VF 124	2
VF 141	2
VF 142	2
VF 143	2
VF 144	2
VF 151	2
VF 152	2
VF 153	2
VF 154	2
VF 171	2
VF 172	2
VF 173	2
VF 174	2
VF 191	2
VF 192	2
VF 193	2
VMF 114	2
VMF 115	2
VMF 122	2
VMF 214	2
VMF 223	2
VMF 224	2
VMF 232	2
VMF 235	2
VMF 311	2
VMF 312	2
VMF 314	2
VMF 334	2
VMF 451	2
VMF 533	2
VMFT 10	2
VMFT 20	2
VMIT 10	2
VMIT 20	2
VMA 323	2
VMJ 1	2
VMJ 2	2
VMJ 3	2
VX 2	2
VX 3	2
VX 4	2
VX 5	2
VC 3	4
VC 4	4
VC 6	4
VC 61	4
VC 62	4
VU 1	2
VU 2	2
VU 3	2
VU 4	2
VU 7	2
ATU 201	4
ATU 601 VP	4
VR 31 F&M NorVa	4
VR 32 F&M SanDiego	4
CVG 1	1
CVG 2	1
CVG 3	1
CVG 4	1
CVG 5	1
CVG 6	1
CVG 7	1
CVG 8	1
CVG 9	1
CVG 10	1
CVG 11	1
CVG 12	1
CVG 14	1
CVG 15	1
CVG 17	1
CVG 19	1
H&MS 11	1
H&MS 12	1
H&MS 13	1
H&MS 14	1
H&MS 15	1
H&MS 24	1
H&MS 31	1
H&MS 32	1
H&MS 33	1
H&HS AFMFPAC	1
H&HS AFMFLANT NorVa	1
H&HS 1ST MAW	1
HedRon MWSG 17	1
HedRon MWSG 27	1
HedRon MWSG 37	1
FAWTULANT	2
FAWTUPAC	2
FA Gunnery Unit, El Centro	2
NAS NARTU Columbus	2
NAS NARTU Dallas	2
NAS NARTU Denver	2
NAS NARTU Glenview	2
NAS NARTU Los Alamitos	2
NAS NARTU Minneapolis	2
NAS NARTU New York	2
NAS NARTU Olathe	2
NAS NARTU S. Weymouth	2
NAS NARTU St. Louis	2
NAS NARTU Willow Grove	2
NARTU Miami	2
NAVADVBASE, Opama	2
NAS NABTC Pensacola	2
JTTUVT Corpus Christi	2
NSAWF NATTC Corpus Christi	2
NAAS NATTC Kingsville	2
NAAS NATTC Corpus Christi	2
NAAS NATTC Chase Field	2
NAAS NATTC Memphis	2
NATU Pensacola	2
NATU Memphis	2
NAVCICOFFSCH Glenview	2
NAOTS Chincoteague	2
INM Boston	2
NLO Edwards AF Base	2
NPU El Centro	2
NOTC Inyokern	2
NASWF Kirtland AF Base	2
NADC Johnsville	2
NACA Langley AF Base	2
NACA Moffet Field	2
NAMC Philadelphia	2
NATC Patuxent River	2
NAMTC Pt. Mugu	2
NADU S. Weymouth	2
AMEL Philadelphia	2
FASRON 2	2
FASRON 3	2
FASRON 4	2
FASRON 5	2
FASRON 6	2
FASRON 7	2
FASRON 8	2
FASRON 9	2
FASRON 10	2
FASRON 11	2
FASRON 12	2
FASRON 104	2
FASRON 117	2
FASRON 119	2
CG, 1ST MAW	2
CG, 2ND MAW	2
CG, 3RD MAW	2
BAR St. Louis	1
BAR Baltimore	1
BAR Buffalo	1
BAR El Segundo	1
BAR Indianapolis	1
BAR Bethpage	1
BAR Columbus	1
BAR Dallas	1
BAGR Central	1
BAGR Western	1
BAGR Eastern	1
O&R Alameda	1
O&R Corpus Christi	1
O&R Norfolk	1
O&R Quonset Pt.	1
O&R San Diego	1
O&R Cherry Pt.	1
O&R Jacksonville	1
OPNAV	10
BUAER	5
ComAirLant	2
ComAirPac	2
CNARESTRA	2
CNATRA	2
AirFMFLant	2
AirFMFPac	2
ComFairAlameda	2
ComFairJax	2
ComFairQuonset	2
ComFairHawaii	2
ComFairJapan	2
CO USN Admin Unit Sandia Base	1
Directorate Flight Safety Research (USAF)	4



Conclusions

1. Emergency escape from aircraft utilizing the ejection seat is a safe, and frequently the only, technique for successfully escaping from high-performance aircraft.

2. Model of aircraft has little influence on the success of an ejection.

3. Altitude, speed and maneuver considered together determine the minimum safe ejection altitude.

4. Ejections following well defined difficulties such as fire, engine failure or structural failure result in fewer fatalities than those which follow poorly defined, such as loss of control. Ejections following loss of control involve 30 percent fatalities, probably because the pilot does not realize the seriousness of the situation and attempts to regain control of the aircraft until reaching an altitude far below the safe ejection altitude.

5. The H-3 and H-4 helmet are satisfactory for ejection provided the chin strap is properly secured. It appears that pilots are not aware of the value of having their goggles in place on a high speed, high altitude ejection.

6. The inherent protection afforded by the face curtain is considered a large factor in the retention of the helmet.

And Recommendations

7. Comparison between the armrest firing technique utilized in the TV aircraft and the standard face curtain firing mechanism utilized in the Navy ejection seat cannot be made since there were only four ejections from TV aircraft. However, the rather extensive experience of the U. S. Air Force with the armrest method of firing indicates that under similar circumstances both methods are equally effective with the exception of (6) above. The fatal rates are almost identical for the two methods of firing.

8. Pilots are not aware of the seriousness of bailout at high altitude without emergency or bailout oxygen.

9. Pilots are not aware of the seriousness of ejecting through the canopy. Two of three ejections through the canopy occurred without attempting the normal procedure.

10. Pilots are not aware of the need for keeping the safety belt and shoulder harness fastened for ejection except at low altitudes. All of the three pilots who ejected with the shoulder harness and seat belt unfastened were above 4500 feet.

11. Bailout from jet aircraft is hazardous.

12. The method of safetying the ejection seat in TV aircraft is not satisfactory.

Recommendations

It is recommended that:

1. Squadron Training Officers conduct a continuing program of ejection seat training to assure that all pilots are thoroughly familiar with the ejection procedures for their particular type aircraft. This should include periodic indoctrination in the Ejection Seat Trainer and familiarization in type as required by Technical Order 99-52.

2. Squadron doctrines concerning ejections be reviewed to insure that pilots are advised to eject from uncontrollable aircraft at an altitude sufficient to permit completion of the ejection procedure and deployment of the parachute.

3. Pilots be instructed to keep their helmet chin straps properly secured at all times in flight so that the helmet and exygen mask will be retained during the ejection.

4. The importance of use of the oxygen bail-out bottle be re-emphasized to all pilots.

5. Pilots be cautioned that ejection through the canopy is not considered desirable.

part 1

General Information

TABLE I

Emergency Ejections by Model of Aircraft

	Number	Per Cent
F3H	2	2
F7U	3	4
F9F-6/7	22	26
F9F-2/4/5	33	39
F2H-3/4	7	9
F2H-1/2	13	15
TV-2	4	5
	84	100

Through 30 June 1954 there have been 84 reported emergency uses of the ejection seat. Fifty-five or 66 per cent of these ejections have been from F9F aircraft. There have been no emergency ejections from TV-1 aircraft.

TABLE II

Emergency Ejections by Cause Factor

	Number	Per Cent
Fire/Explosion	22	26
Loss of Control	20	24
Engine Failure	16	19
Structural Failure	14	16
Mid-air Collision	8	10
Vertigo	1	1
Unknown	3	4
	84	100

As can be seen in Table II, the emergencies under which these 84 ejections were made are, in general, those situations under which the possibility of making a forced landing is remote.

TABLE III

Emergency Ejection by Speed at Time of Ejection

Speed	Number Cases	Per Cent Cases
100-199 (knots)	18	21
200-299	26	31
300-399	17	20
400-499	8	10
500-up	4	5
Unknown	11	13
	84	100

The highest speed at which an ejection was made was about 520 knots (IAS).

TABLE IV

Emergency Ejections by Altitudes at Time of Ejection

(All altitudes above terrain)

Altitude	Number Cases	Per Cent Cases
0-999 (Feet)	10	12
1000-1999	4	5
2000-2999	4	5
3000-3999	4	5
4000-4999	5	6
5000-9999	23	27
10,000-19,999	21	25
20,000-29,999	3	4
30,000-up	6	6
Unknown	4	5
	84	100

The highest altitude at which ejection was

made was 36,100 feet and the lowest was from ground level. However, excluding this rather unique non-fatal case, the lowest non-fatal ejection was from an altitude of 1300 feet.

TABLE V

Emergency Ejections by Maneuver at Time of Ejection

Maneuver	Number Cases	Per Cent Cases
Level	39	46
Spin	15	18
Inverted	1	1
Bank	3	4
Climb	1	1
Dive	9	10
Roll	3	4
Spiral	5	6
Unknown	8	10
	84	100

As can be seen in Table V, ejections have been made from almost every attitude possible. However, the majority of ejections have been made from a straight and level attitude.

TABLE VI

Injuries Sustained in Emergency Ejections

Injury	Number Cases	Per Cent Cases
Lost/Missing	5	6
Fatal	13	15
Major	14	17
Minor-None	52	62
	84	100

Fifty-two (or 62 per cent) of the emergency ejections resulted in minor or no injuries. Thirteen (or 15 per cent) resulted in fatal injuries. Five of the cases are classified as lost or missing, three of which are listed as presumed drowned. Combining these, there are 16 presumed fatalities (19 per cent).

part 2

ANALYSIS

1. Influence of Model of Aircraft

There is no evidence to indicate that model of aircraft has any relation to the success of an ejection. The TV aircraft is equipped with the arm-rest firing seat. However, too few ejections have been made from this aircraft to permit direct comparison. The majority of aircraft flown by the U. S. Air Force utilize the arm-rest firing method. In general, the ejection history is similar.

2. Influence of Cause Factor

Cause factor does have an indirect influence on the success of an ejection. Table VII presents this information.

As can be seen in this table, 30 per cent of the pilots who ejected following loss of control received fatal injuries. However, this is misleading since altitude must be considered a determinant in five of these cases (the pilot

TABLE VII

Injuries and Cause for Ejection

Cause	Number Cases	Lost/Missing		Fatal		Major		Minor/None	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Fire	22	2	9	1	5	6	27	13	59
Loss of Control	20	—	—	6	30	2	10	12	60
Engine Failure	16	—	—	1	6	2	13	13	81
Structural Failure	14	2	14	1	7	4	29	7	50
Mid-air Collision	8	1	12	1	12	—	—	6	75
Vertigo	1	—	—	—	—	—	—	1	100
Unknown	3	—	—	3	100				
TOTAL	84	5	6	13	15	14	17	52	62

received fatal injuries on landing in the sixth case). In all five cases the pilots ejected below 1000 feet and three cases were in high speed dives.

Probably the only category that directly affects the success of an ejection is the mid-air collision category. Damage to the aircraft may be incurred in the mid-air collision which can prevent the jettisoning of the canopy and may result in actual damage to the ejection seat.

3. Influence of Speed (IAS) on Ejection

There is little direct relation between speed on ejection and the success of the ejection. Speed becomes a determining factor when considered with altitude and maneuver (see paragraph 6 — Critical Determinants of Successful Ejection). High speed, however, plays an important part when the effects of wind blast are considered. Retention of mask is vital at high altitudes.

4. Influence of Altitude on Ejection

Altitude is one of the critical determinants of successful ejection but again must be considered with speed and attitude. Table VIII presents the injuries by altitude on ejection.

TABLE VIII

Injuries and Altitude on Ejection

Altitude	Number Cases	Lost/ Missing		Fatal		Major		Minor/ None	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0-999 (Feet)	10	1	10	8	80	1	10	—	—
1000-1999	4	—	—	1	25	—	—	3	75
2000-2999	4	1	25	—	—	1	25	2	50
3000-3999	4	—	—	—	—	1	25	3	75
4000-4999	5	1	20	—	—	1	20	3	60
5000-9999	23	—	—	—	—	4	17	19	83
10,000-19,999	21	1	5	2	10	3	14	15	71
20,000-29,999	3	—	—	—	—	1	33	2	67
30,000-up	6	—	—	—	—	2	33	4	67
Unknown	4	1	25	2	50	—	—	1	25
	84								

5. Influence of Maneuver on Ejection

Again, maneuver has little direct influence on the success of an ejection but rather must be considered with altitude and speed as one of the critical determinants. The dive maneuver is, of course, one of the most critical for ejections since altitude is lost rapidly.

Critical Determinants of Successful Ejection

The critical determinants of a successful ejection are altitude, speed and maneuver. These three considered together, determine the time available and the forces which will be encountered. A *normal* ejection will probably consume about 10 seconds, although it can be completed in a shorter time with thorough knowledge of the ejection process, frequent simulated training in the process, low pilot reaction time and use of the low altitude ejection procedure.

In the same sense, the procedure can take considerably longer if the pilot is not familiar with the procedure, i. e. debates as to ejecting or attempting to control the aircraft or has a slow reaction time as a result of anoxia, fatigue, etc.

The ejection time sequence is approximately as follows:

1 to 2 seconds to eject
5 to 7 seconds to clear the seat
2 seconds to open the parachute.

This does not include the time to arrive at the decision to eject, which is probably the most critical, and can absorb more time than the entire ejection procedure. Thus, the decision to eject must be made at safe altitudes for ejection. For example, if the aircraft is in a spin it may be losing altitude at the rate of 20,000 feet per minute or almost 350 feet per second. A 45-degree dive at 450 knots means over 500 feet per second loss of altitude. Change the angle to a 60-degree dive and the aircraft is decending at over 660 feet per second. Another factor is in the decision to eject. This is the altitude required to recover. For example, should the FJ-3 enter a spin below 7000 feet of altitude, the decision to eject immediately is already made since it is improbable that sufficient altitude remains for recovery.

Level flight presents a different picture as there is no initial vertical velocity. Ejection below 1000 feet is possible but hazardous. For safety, expend any extra airspeed in altitude if at all possible.

All of the information points to one axiom for ejecting — *pre-planning*. If a pilot has established conditions under which he will eject and has mentally rehearsed both the conditions

and ejection procedure repeatedly, he will probably complete the ejection under emergency conditions in a much shorter period of time, and more likely, before realizing that it has been accomplished.

7. Loss of Equipment

Table IX presents the loss of helmet and mask in the 84 ejections.

TABLE IX

Loss of Helmet and Mask in Ejections

Type Helmet	Lost Outer	Lost Both	Not Lost	Unknown	Total
H-1	—	9	2	1	12
H-3	2	8	38	9	57
Unknown	—	3	0	12	15
Total	2	20	40	22	84

As can be seen in Table IX, the H-3 helmet is more often retained on ejection than was the older H-1 helmet. In the two cases in which only the outer shell was lost, the oxygen mask was retained since it is fastened to the inner liner.

Table X presents the information on when the helmet was lost.

TABLE X

Time of Loss of Helmet

Model	Phase: As Canopy Jettisoned	Ejection Wind Blast	Chute Opening
H-3	4	3	1
H-3 (outer only)	1	1	—
H-1	3	5	1
Unknown	3	—	—
Total	11	9	2

As can be seen in this table, helmets are lost about equally in the wind blast following the loss of the canopy and in the wind blast encountered on entering the slip stream.

In some of the cases it is believed that the helmet was not properly secured at the time of ejection. When properly worn, the H-3 helmet has been retained at speeds in excess of 400 knots (IAS). Retention of the helmet and thus the oxygen mask is vital at high altitudes where bailout oxygen is essential.

8. Bailout Oxygen

Bailout oxygen was used in six ejections. There are two additional cases in which an attempt was made to use bailout oxygen but was unsuccessful. In one case, the bailout tube had not been connected prior to ejection and in the second case, the bailout oxygen tube was severed during the ejection. The cause could not be determined.

An investigation of one ejection revealed that, although the pilot was flying at 33,000 feet, he did not have bailout oxygen equipment. On another case a pilot ejected at 36,000 feet without bailout oxygen. He had forgotten to check it.

9. Injuries and Ejections

A. Fatal Injuries

Of the 13 fatal ejections, three ejected at safe altitudes (all about 5000 feet) and fatal injuries were received on landing. Two of these cases were drownings. One was the result of entanglement with the shroud lines following a water landing. The pilot was found with the life vest inflated, free of the chute harness, but entangled in the shroud lines. The second case of drowning was the result of dragging in a 25-knot surface wind. Helicopter rescue was too late to save the pilot. The third fatality in this group was the result of an injury sustained on landing. The pilot struck a rock on landing, resulting in a fractured vertebra which proved fatal.

All of the remaining 10 fatal ejections were from altitudes below 3000 feet. All but one were below 1000 feet of altitude. In eight of the ejections, the pilots were found still strapped in the seat. In two cases the ripcord had been pulled but the seat belt had not been unfastened. In none of these eight cases had the pilots ejected as recommended in BuAer Technical Note 28-52 which recommends unfastening the seat belt prior to ejection below 2000 feet. In the two cases in which the pilot cleared the seat, the parachute did not have time to deploy before contacting the ground. One of these ejections was from about 500 feet and one was from about 900 feet. It

could not be determined if the pilots had ejected with the seat belt unfastened.

Five ejection cases are classified as lost or missing. Three of these cases are classified as presumed drowned. In one case the pilot ejccted at about 5000 feet, but for some reason did not leave the seat and was observed to hit the water still strapped in the seat. Neither the pilot nor the seat was recovered. Investigation could not determine why the pilot had not separated from the seat. In the second case, the pilot was observed to jettison the canopy at about 500 feet and then begin a glide toward some ships on the surface. Shortly before hitting the water, the pilot was seen to eject from the cockpit. The parachute was not seen to open. Neither pilot, seat nor airplane was recovered. In the third case, the airplane was seen to explode in flight at about 3000 feet. The wreckage of the airplane was recovered from a river and indicated that the seat catapult had been fired. Neither the seat nor pilot was recovered.

The remaining two cases are classified as missing. There is very little information available other than that they are known to have ejected. Both of these pilots are believed to have been alive after landing.

B. Major Injuries

There were 14 serious injuries sustained in these 84 ejections. Seven of these major injuries were directly associated with the ejection sequence. Three of these involved back injuries. All were the result of poor position on ejection. In one case the pilot had unfastened his seat belt and attempted to bail out. After finding that G forces prevented bailout, he operated the ejection seat successfully. A fractured coccyx was sustained on firing the catapult, and it is believed that the pilot was raised above the seat on firing.

There were two other cases of strains and contusions of the back from poor position on ejection. The fourth major injury on ejection is considered unique. The canopy of a TV-2 was jettisoned by normal opening. The catapult tube remained with the aircraft and when the rear seat occupant ejected, the pilot's arm struck the tube, resulting in a simple fracture of the right arm.

Three of the major injuries are believed to have been sustained in the wind blast following ejection. All were at speeds believed to be in excess of 350 knots. Two were believed to have been at about 500 knots (IAS). All three injuries were similar. In the first case the pilot sustained a fracture of the left femur and chip fractures of both humeri. In the second case the pilot sustained a simple fracture of both femura, and in the third case the pilot sustained a comminuted fracture of the right thigh and minor facial injuries from the wind blast. These injuries are believed to have resulted from extreme abduction by the wind blast or possibly on parachute opening.

Four of the major injuries were sustained on landing following ejection. In two cases the pilots had pulled the ripcord before leaving the seat, and in one case this resulted in the seat damaging the chute. The fourth major injury on landing is unique. The pilot ejected just before the plane stopped during a slide out on a wheels up forced landing. The pilot struck the ground still strapped in the seat and sustained serious but not fatal injuries.

Two of the major injuries were sustained on parachute opening. In one case the pilot's legs were entangled in the shroud lines resulting in a back injury when the chute deployed. The second case consisted of contusions from the harness and a back sprain.

The remaining major injury consisted of severe facial burns sustained in the cockpit prior to ejection.

10. **Ejection Through the Canopy**

There were three ejections through the canopy. All sustained only minor injuries. The first case involved a pilot flying with a loose safety belt. The airplane went out of control and the pilot was forced up against the canopy by negative G. He was unable to reach the pre-ejection lever because of his raised position and proceeded to use the emergency safety pin handle and eject through the canopy. The

remaining two pilots elected to eject through the canopy, one following loss of control and the other following fuel exhaustion. No injuries were sustained in the passage through the canopy.

However, the possibility of injury from flying plexiglass is great. Normal ejection procedure is recommended where possible. Ejecting through the canopy **should be reserved** as an emergency measure.

11. Ejection with Safety Harness and Seat Belt Unfastened

Three pilots ejected with the seat belt unfastened. One was at 32,000 feet, one at 6000 feet and one at about 4500 feet. No injuries were sustained on ejection.

This procedure is recommended in T.O. 28-52 for ejection below 2000 feet to speed the opening of the parachute. It is not recommended at higher altitudes where time is not a problem since there is nothing to keep the pilot in the seat with the belt unfastened. Thus with negative G forces, and out-of-control aircraft, the pilot could be thrown about the cockpit, out of position for ejection resulting in serious injury, or at the extreme, be sufficiently pinned forward or upward to be out of reach of the face curtain. This procedure should be reserved for low altitude where time is of prime importance for survival.

12. Difficulties in Ejection

A. Canopy

The major difficulty in ejection has been in jettisoning of the canopy. There were seven cases which involved this difficulty. In one case, a TV-2 airplane, the canopy remover was not installed and the canopy was jettisoned by manually opening it. In the remaining six cases, the canopy failed to jettison with the pre-ejection lever. As a result, in three cases, the canopy was jettisoned with the emergency jettison lever and in three cases opened by manual force until the wind blast tore it off.

The possibility of canopy difficulties led to the installation of an emergency safety pin removing handle in all but the TV aircraft. This permits manual removal of the safety pin and ejection through the canopy when the canopy cannot be jettisoned. A modification to the TV-2 aircraft, beginning with Bureau Number 136793, also permits ejection through the canopy.

B. Miscellaneous Difficulties

In two cases the life vest inflated on ejection. In both cases, it is believed that the toggles were under the seat belt and were pulled sufficiently to inflate the vest on ejection.

There were five cases in which the ejection seat contacted the parachute. In two cases the pilot had pulled the ripcord before releasing the seat. Thus the parachute deployed as the seat left. In two cases the seat fell into the parachute. In the remaining case, the D-ring was pulled inadvertently sometime during the ejection and parachute deployed as the seat left after releasing the seat belt. The seat caught in the shroud lines and remained there during the descent. In no case did the seat strike the pilot.

There were three cases in which the seat became entangled with equipment. In one case the leg brace caught in the parachute harness leg strap. A modified leg brace has precluded this occurrence. In the second case, the pilot noticed that the seat was hanging by a lanyard after he had pushed away from it and opened the parachute. He severed the strap with a knife and the seat fell away. The strap was either the liferaft lanyard or the helicopter hoist lanyard. The cause is believed to have been improper routing of the lanyard.

In the remaining case, investigation revealed that the oxygen supply hose had been responsible for keeping the seat attached to the pilot who had apparently routed the hose under his parachute harness. The pilot successfully opened his parachute and landed with the seat still hanging by the hose.

In six cases, the pilots pulled the ripcord prior to releasing the seat belt. Two of these cases were fatal. Both were low altitude ejections. One of these might have been suc-

cessful if the pilot had used the proper sequence as directed in BuAer T.N. 28-52. He ejected at about 1500 feet of altitude at slow speed in level flight. He was found still strapped in the seat with the ripcord pulled and the D-ring in his hand. In three of the non-fatal cases, pulling the ripcord before releasing the seat belt resulted in the seat catching in the parachute.

In one case the pilot ejected from an F9F-4 with the canopy in the open position utilizing the emergency safety pin pulling handle. As a result, he struck the canopy bow on ejection. The ejection occurred in the landing pattern at an estimated altitude of 100 feet. The pilot probably received incapacitating, if not fatal, injuries on striking the canopy bow.

13. Inadvertent Operation of the Ejection Seat

There have been five inadvertent ejections. Two of these resulted in serious injury. The first case involved maintenance personnel. The canopy had been removed. It is believed that the safety pin was removed, and that one of the ground crew may have accidentally pulled the firing cable. The exact nature of the injuries sustained is unknown but it is believed that two men were injured.

The second case involved a pilot receiving a simulated ejection seat operation training as recommended by BuAer T. O. 99-52. The cartridge had **not** been removed from the catapult. The pilot was ejected when he pulled on the curtain for what he thought was a dry run. Serious injuries were sustained.

The remaining three cases all involved TV-2 aircraft. Two cases involved ground crewmen. Neither aircraft was equipped with the M-3 initiators. Both cases were the result of inadvertently raising the armrest. **In neither case was the safety pin in place as required.** One man received serious injury, the other minor. The last case involved a TV-2 equipped with the M-3 initiator. The pilot did not place the safety pins in place after landing and, in removing his parachute from the seat, inadvertently raised the armrest. Fortunately, the pilot was clear of the path of the seat and received only minor injury to his hands.

14. Bailouts from Ejection Seat Equipped Aircraft

There have been 10 bailouts from jet aircraft equipped with the ejection seat. Five were from F9F aircraft, three from F2H aircraft, and two from TV aircraft. Three of the five F9F bailouts were fatal, and one is classed as missing. The remaining case received minor injuries. Two of the F2H bailouts resulted in serious injury and one in minor injury. The TV bailouts resulted in one serious injury and one minor injury. In four cases (2-TV; 2-F2H), the pilots were thrown clear of the aircraft on releasing the seat belt. One of the F2H bailouts which resulted in serious injury was the result of improper rigging of the ejection seat securing dogs. The pilot and seat fell through the canopy when the aircraft was in a roll. In four of the five F9F bailouts the pilots struck the tail surface, resulting in fatal injuries in one case.

Selected Cases

High Speed High Altitude Ejection — F9F-6

1. The pilot was flying at 40,000 feet when the engine exploded. Shortly after, the plane entered a steep dive and was uncontrollable. The pilot ejected at about 30,000 feet at over 500 knots (IAS). No difficulties were encountered although the shock on hitting the slip stream was severe. The pilot held the face curtain tightly over his face until he felt he was slowed to about terminal velocity. The pilot was wearing an H-3 helmet and A-13A oxygen mask. Both remained in place during the ejection. The pilot **did not** have bailout oxygen, so decided to free-fall. The ripcord was pulled

at approximately 5000 feet of altitude as estimated by the base of the clouds. The pilot had free-fallen about 25,000 feet. Parachute oscillations were damped by pulling the high risers. An easy landing was made in a cultivated field. The pilot sustained only minor facial injuries from the wind blast and mild abrasions of the body from the parachute harness.

Ejection through the Canopy

2. The pilot, low on fuel, decided to ditch his plane near some ships on the surface. During the descent through a hole in an overcast, the engine flamed. The pilot decided to eject rather than attempt a power-off landing. In preparation for the ejection, the pilot disconnected all leads, removed the knee pad, tightened the parachute harness, unfastened the seat belt and shoulder harness, and pulled the safety pin with the emergency arming handle, after electing to eject through the canopy.

The plane at this time was slightly below 5000 feet, in level flight indicating 160 knots. The pilot had planned to make a practice pull on the curtain, then make certain the aircraft was level, before pulling the face curtain to fire the seat. However, the practice pull was sufficient to fire the seat. He pulled the ripcord immediately and descended to the water. A 15-knot surface wind immediately began dragging him so the lower risers were pulled to collapse the chute.

Twice, the pilot thought that the chute was collapsed, but each time it again filled with air and began dragging him across the water. The third time the pilot submerged the chute. By this time he was well entangled in the shroud lines so he immediately inflated his pararaft and crawled aboard. Rescue was effected in about 30 minutes by a cruiser. The pilot's only injuries were mild contusions of the trunk and extremities from the parachute harness.

Ejection from Uncontrollable Spin — F7U-3

3. Pilot's statement — "I conservatively estimate that the plane spun seven turns prior to my ejection. When I decided to eject I pulled my feet back, turned and looked at the face curtain handle as I grasped it, turned my head forward and pulled the curtain at an estimated altitude of 7000 feet. During the first part of the curtain travel, the canopy jettisoned and I continued to pull until the seat ejected. There was no hesitation — just a steady, light pull to accomplish the dual purpose of the curtain.

"I received a sharp blow on the head during the ejection. I believe my H-3 helmet had lifted slightly when the canopy left the plane, and when I was fired the sudden contact with the helmet was sufficient to cause a sharp pain. After the ejection, I released the seat belt without detaching my microphone and receiver cords and A-13A oxygen mask as I had the webbing on the end of my mask placed around my parachute chest buckle and secured. As a result, when the seat and I parted, the cords and oxygen hose snapped out of the plug-in receptacles and the oxygen hose could not stretch and snap back. After discovering the seat below me, I reached for the D-ring and discovered I had subconsciously pressed it to my side with my left arm. I immediately pulled the ripcord with my right hand and did not notice any appreciable shock on chute opening."

The pilot landed easily on soft marshy ground and was picked up. The only injuries were some mild abrasions from the parachute harness.

Low Altitude Fatal Ejection

4. Three aircraft on a tactics hop entered a transonic dive from 38,000 feet. The leader leveled out at 16,000 feet, the number two man at 13,000 feet, and the number three man was seen to begin a pullout at about 22,000 feet. Witnesses noticed the airplane at about 1500 feet in a nose down attitude and losing altitude rapidly with power on. It was apparently out of control in a sweeping turn. The canopy was seen to fly off, and, as the airplane went into a violent diving turn, the pilot was seen to eject. The altitude was estimated at less than 400 feet above the terrain, and the speed in excess of 500 knots. The airplane crashed in a 80-degree dive inverted. The pilot's body was found 78 feet from the plane still strapped in the seat with the D-ring untouched. In his right hand was the bailout bottle release knob.

Ejection Seat Publications

T.O. 24-52 Model F9F Airplanes; ejection seat adjustment and securing mechanisms, operation and inspection of

T.O. 27-52 Instructions for personnel handling crashed aircraft incorporating ejection seats

T.O. 41-52 Model F9F Airplanes; emergency escape procedures

T.O. 99-52 Ejection Seat Installation; inspection of

T.O. 107-52 Pilot Ejection Seat; instructions for emergency use of

T.O. 17-53 MK-1, Mod O, Personnel Ejection Catapult Cartridge; handling procedures

T.O. 12-54 Emergency Oxygen Equipment; installation of

T.O. 13-54 Emergency Oxygen Equipment; procedures for use of

T. O. 44-50 Description of installation; Instructions for operation, inspection, storage and shipment
Remover, Aircraft canopy, M1, with cartridge

T. O. 93-53 Emergency Escape Provisions, inspection of

NavAer 03-1-599 Handbook of Overhaul Instructions for Personnel Ejection Catapult, NAF types I and U-1.

T.N. 28-52 Ejection Seat; escape procedures at low altitude

T.N. 15-53 F2H Pilot Ejection Seat, pre-ejection disconnect arm, information concerning

NAVA 00-80Q-37 Shoot Seat Sense (Ejection Seat)

NAVA 00-80Q-5 Parachute Sense

Movie

MN-6703 Emergency Escape Using Pilot Ejection Seats